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POSSIBILITY OF SMALL SCALE DEVELOPMENT OF OIL NATURAL GAS, COAL AND PEAT IN ORDER TO REDUCE THE PRESSURE ON BIOMASS FUEL SOURCES: CASE OF BURUNDI AND MADAGASCAR

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Introduction

1. The disturbing energy situation is one of the major factors limiting Africa's economic development. As it could be observed from the available statistics for 1984-1989, energy consumption is rising faster and faster in the African member States upto the point of arousing serious anxieties about the continent's future energy supplies. The economic crisis endangered by rising energy prices may increase and cause a disorder hampering the implementation of the programmes of economic recovery (APPER, UN-PAAERD and AAF-SAP) which recently have brought together the developing Africa and developed world.

2. The strategy for Energy Development in Africa was formulated in the Lagos Plan of Action which called upon member States to follow policies which will enable the energy sector to make the proper contribution to economic well-being. This required among other things well-balanced energy economies and a reduction in the vulnerability to energy disruptions and in the individual and collective dependance on imported oil. African states are also in need of establishing a coherent energy strategy, in preparing and obtaining fundings for urgent and high priority energy projects and in identifying the most pressing requirements for technical assistance in the energy sector.

3. The Lagos Plan of Action also envisaged that African states should take common measures to reduce barriers to intra-African energy trade, maintain effective arrangements for handling disruption in oil supplies. As a result African states are relying on a combination of market forces and government action to secure well-balanced energy economies and the governments have a special responsibility for the security of energy supply in both the short and long term. The member States are committed to policies which help to avoid in the future the disruptive economic effects which have been experienced in the past by African countries as a result of developments in world oil market.

4. The programme of work of ECA in the energy sector for 1990 has envisaged the preparation of the technical publication on the guidelines on the possibility of development of small oil, natural gas, coal and peat resources in some Eastern African member States in order to reduce the pressure on biomass fuel sources.

5. The board objectives of this technical publication are to analyze availability of domestic conventional sources of energy in some selected African member States. The major objective is to survey energy options in Burundi and Madagascar endowed with depostis of oil and gas, tar sands and coal (Madagascar), and peat (Burundi).

6. The present situation with biomass in this part of Africa is critical. Despite being relatively abundant at some localities, biomass is generally scarce in the above mentioned African countries. Developing of biomass energy offers numerous opportunities in African countries. However in view of the immenent shortages of this source of energy, the idea

to utilize locally available small deposits of petroleum, natural gas, coal and peat becomes very attractive. These non-renewable sources of energy are used almost exclusively in urban areas for water supply and electricity generation as well as for lighting, heating, cooling and cooking of food.

7. Burundi being the Least Developed Country is particularly vulnerable to the higher price of oil. The sharp escalation of petroleum prices set off by the on-going Gulf crisis can only worsen the adverse impact on the balance of trade and overwhelming dependance on petroleum for commercial energy in Burundi and Madagascar.

8. For Burundi and Madagascar with no crude oil production, oil imports constitute more than half of their import bill, therefore the economic incentive to develop indigenous conventional energy resources will remain strong. The discovery of crude oil and natural gas, even on a small scale, can aid significantly in financing the further developemnt in these countries.

9. One of the lessons learnt in Africa at the time of the two oil schocks in 1970s was realization of a need to develop a sound energy policies in future. These were formulated as follows: -to maintain energy security through continued development of indigenous energy resources and technologies and improvements in the efficiency of energy use; - secure the benefits for African countries as a whole, of lower energy and oil prices; - promote free and open trade in energy; and - further improve preparedness to deal with a disruption in energy supplies.

10. As reported in Burundi's contribution to the second United Nations Conference on the Least Developed Countries, (1) Burundi imports all the petroleum products it uses; they make up 20 per cent of imports and absorb 40 per cent of export earnings. The development planned, particularly for industry, will make this constraint still worse. In addition to research, efforts are being concentrated on the establishment of a safety stock. The construction of hydroelectric stations is under way and process of conversions of the industrial establishment to electricity or peat has already been started.

11. The ECA study has concerned itself with what for many African Governments is the highest priority issue, that is how to attract upstream investment into their countries or how to expand the effort that is already being made. This report is to discuss the aspects of practical operation of small oil and gas fields in Madagascar, coal field in Madagascar and peat deposits in Burundi. The difference between small scale operation and a major undertaking is clearly understood, because they operate in an entirely different manner. The paper summarizes what is known about conventional resources in these selected countries, reviews the history of exploration to date, assesses the prospects of resources development consistent with the countries overall energy development strategies.

II. AVAILABILITY OF OIL, NATURAL GAS AND COAL IN AFRICA

(a). Oil and Natural Gas

12. Oil plays a vital role in the economic life of Africa. Oil exports are an important source of national income and foreign exchange earnings for African oil producing countries. For the consuming Africa, however, this commodity, which is the principal source of energy for modern industrial development and agriculture imposes a heavy burden on their scarce foreign exchange resources.

13. It is evident that oil and natural gas will remain the basic components of the energy mix in the majoirty of African countries in the forseeable future. With the recent hike in oil prices Africa still heavily rely on fossil fuels and today many African countries depend almost entirely on petroleum imports for their energy needs.

14. Forecasts of future petroleum consumption in Africa indicate that African member States will continue to depend on oil and gas as their main commercial primary energy source well beyond the year 2000. African countries with a few exception have not been able to adjust to the high price of oil in the past despite the adopted conservation measures and investments made in renewable sources of energy.

15. Nevertheless the critical energy situation in Africa has brought about some improvements in investments for exploration and development of indigenous oil and gas resources although the collapse of oil prices in 1986 and the deep indebtedness of so many African countries have once again brought about a significant reduction in these efforts.

16. The multinationals which in the past have been attracted to Africa started to pull out because of the worldwide downturn in exploration activity. But this trend is apparently not in the interests of African countries which still are in need to strengthen their national capacity in exploration for indigenous oil and gas. Furthermore they would like to give a consideration to enhance technical co-operation among themselves through appropriate regional and subregional arrangements and also seeking the assistance of multilateral oranisations.

17. Typically a large part of the African member States foreign exchange reserves is spent on the importation of crude oil and products for conversion into energy, and costs are still onerous in terms of available resources as compared to the multiplicity of needs which exist.

18. Many of these African countries have undeveloped hydrocarbon resources within their national boundaries which if brought into production, would significantly alter their national economies. There are still large areas in Africa which need to be fully prospected if a complete inventory of their resources is to be made. Some African countires have skilled staff but too few of them to undertake the prospecting of vast regions.

Encouragement should therefore be given to the formation of joint prospecting missions, the training of personnel in countries having the necessary training facilities and expereince and the establishment of new subregional and regional institutions.

19. The exploration stage in the oil industry requires large investment and highly skilled personnel. The establishment of joint African ventures would be one way of tackling the problem. African producing countries with the necessary experience and staff could set up joint ventures with other African countries and could also provide financial backing and training. The joint ventures could concentrate on areas which are the responsibility of African governments under existing concession agreements. Governments would thus be in a position to control the oil industry more closely and increase their participation in it. It would also be possible and profitable to exchange exploration data on neighbouring countries.

20. There are a number of reasons explaining slow development in exploration for indigenous oil and gas in Africa but the major probably is high external indebtedness of African countries. The ten African petroleum producing countries (ppc) as well as the remaining fourty which are petroleum importing countries (pic) all have substantial external debts which they are finding difficult to service and repay because of petroleum prices. Declining availability of petroleum products in most pics have recently been endangering development.

21. Although the African continent has 13 million sq. km. of sedimentary basins (17.5% of the total sedimentary basin area in the world) only 3 to 4 percent of total world petroleum exploration/production expenditure to-date has been in Africa. Nevertheless the extent and pace of petroleum exploration and production in Africa is at present decreasing rather than increasing. International firms exploring for petroleum in African countries are deliberately restricting their activities to on-shore and near-shore concessions.

22. Alone the substitution of petroleum from an oil field which intensive exploration may discover within its borders, for currently imported quantities, wou'd be immense economic benefit, especially to the poorer land-locked African pics. Small skid-mounted refineries could quite economically refine the modest quantities of domestic crude oil to supply produce for internal consumption.

23. Crucial question however is whether in general petroleum exporting countries, and the international oil firms which are experiencing a perciptuous decline in sales volume and prices would be in favour of such intensive exploration as any significant discoveries and exploitation would diminish international demand and increase the downward pressure on oil prices.

24. At present there are only ten African ppcs. These fall geographically into two focal areas: (a) the Mediteranean countries: Egypt, Libya, Tunisia, Algeria; (b) the Gulf of Guinea countries: Cote d'Ivoire,

Nigeria, Cameroon, Gabon, Congo and Angola. Substantial discoveries of petroleum and/or gas that have yet to be exploited exist in Chad, Sudan, Ethiopia, Tanzania and Mozambique.

25. The 1987 petroleum production in the ten African ppcs totaled 254.6 million metric tons (Mmt) and these countries consumed 52.6 Mmt (20.6%) and exported the rest, most of it to Europe and North America. Algeria and Libya exported natural gas in addition to oil. All other producers either flared associated gas at the well head or reinjected it into the well to enhance oil recovery.

26. African countries imported a total of 16.8 Mmt (6.6%) crude oil and petroleum products in 1987. Eastern and Southern African countries imported crude and petroleum products from the Arabian peninusla and West African countries from North African and West African ppcs. In most pics annual imports of crude and products are well below 1.0 Mmt.

27. For many African oil producing countries, it is not the physical resource base which determines present and future preferred production levels but:

-revenue requirments, which are determined in part by the size of their population. They are also determined in part by desired investment internally on infrastructure and industrial development;

-Debt servicing requirments;
-Overseas investment plans or a desired build-up of other foreign assets;
-the protection of the existence of an adequate-sized oil market at reasonable selling prices into the future, so that their oil resource base continues to have saleable potential; and
-social and political factors.

28. These circumstances point to the need for collaboration between producing and consuming African countries in short medium, and long-term policies on oil exploration, production, processing, supply distribution, marketing and consumption. Such collaboration should focus in particular on the interests of both oil producing and consuming countries, other forms of energy and the need to reduce the influence of third parties on the processing, marketing and price of oil and its products and their priority supply to consuming African countries.

(b).Coal

29. Africa possesses a coal potential that exceeds the presently known figure or 160 billion tonnes of coal in situ. Of this figure, there are 75 billion tonnes in situ regarded as "mineable reserves", that could be exploited under current technical and economic conditions. It is resulting from these cirucmstances that only approximately 10-20% of the afore-mentioned mineable reserve figure will finally end up in form of saleable coal products. Even such reduced reserve figure, however, constitute a very large potential coal production in Africa

for centuries to come. Moreover, estimates of reserves and resources are representing only the status of the present knowledge and will still increase in the forseeable future with the results of further exploration work or of improving market conditions.

30. The overall production of coal in the continent amounted to 181.4 Million tonnes in 1986. Of this figure approximately 40.65 million tonnes appear to be exported of which approximately 40 Million tonnes being steam coal are being shipped to overseas customers in industrialized countries. In 1990, 234 Million tonnes are expected to be produced (6.5% growth per year) of which 65 Million tonnes will be exported in the international coal market. African countries (excluding RSA) are producing approximately 6.0 Million tonnes of coal in 1986 and expect to increase this figure to 8.9 Million tonnes in 1990 (10% growth per year). Only slightly more than 0.65 Million tonnes report to intra-African trade in 1985, which will be increased to 0.83 Millions tonnes in 1990 and which will entirely be covered by the Southern African Subregion.

31. The overwhelming proportion of Africa's mineable coal resources (14.5 billion tonnes or 95.0% of total coal resources) are concentrated in several of the countries comprising the Southern African Development Co-ordination Conference (SADCC) and Madagascar. The distribution of these coal resources within the SADCC/PTA subregion is as follows: Botswana 7,910 million tonnes or 54.5% of the subregional total, Madagascar 60 million tonnes or 0.4%; Malawi 16 million tonnes or 0.1%; Mozambique 285 million tonnes or 2.0%; Swaziland 1,100 million tonnes or 7.6%; Tanzania 320 million tonnes or 2.2%; Zambia 95 million tonnes or 0.7%; and Zimbabwe 4,718 million tonnes or 32.5%. Thus, in terms of current estimates mineable coal tonnages endowment, Botswana, Zimbabwe and Swaziland are the richest among the SADCC/PTA countries accounting for 94.6% of the subregional total.

32. The Economic Community of West African States (ECOWAS) possesses 638 million tonnes or 4.2% of the presently known mineable coal resources of Africa, located largely in Nigeria and to a lesser extent in Niger. Nigeria's share of the ECOWAS mineable coal resources is of the order of 99.1%.

33. The Economic Community of Central African States (ECCAS) is credited with 81 million tonnes or 0.5% of the known mineable coal resources of Africa. These coal resources are all located in Zaire. Thus, the ECOWAS and ECCAS coal resources are not as widely distributed among the countries of the respective subregions as is the case within the SADCC/PTA subregion.

34. The North African subregion's portion of the presently known mineable coal resources is only 39 million tonnes or 0.3% of total Africa largely distributed within Algeria, Egypt and Morocco.

35. In addition, the SADCC subregion is reported to posses large quantities of excellent mineable coking coals which do not seem to occur

in appreciable quantities in other subregions of Africa. These coking coals are located in Mozambique and Zimbabwe.

36. Although the ECA research on coal has covered Eastern and Southern African countries more comprehensively than the rest of the region, geological inference would suggest that even after the research is completed, the Eastern and Southern African countries might prove to have the largest share of mineable coal resources in Africa.

37. In terms of tonnages produced, the countries of Africa produce minor amounts of coal compared to their coal resources potential. During 1985, the total production of saleable coal in the countries amounted to nearly 5.5 million tonnes. Of this total, the SADCC subregion produced 77.0% or 4.2 million tonnes. The distribution of the 1985 saleable coal production within SADCC was as follows: Botswana 480 thousand tonnes or 11.4%; Malawi 10 thousand tonnes or 0.2%; Mozambique 25 thousand tonnes or 0.6%; Swaziland 160 thousand tonnes or 3.9%; Tanzania 7 thousand tonnes or 0.2%; Zambia 485 thousand tonnes or 11.5%; and Zimbabwe 3,045 thousand tonnes or 72.2%.

38. The SADCC coal production proportion would have been higher than that which was achieved largely because the existing production capacity in Mozambique was made inoperative. In 1981, Mozambique produced about 500,000 tonnes of coal compared to the 25,000 tonnes produced in 1985.

39. Coal production during 1985 for the North African subregion amounted to 850 thousand tonnes or 15.5% of Africa's output. All this coal was produced by Moroçco. Within the ECOWAS subregion 290 thousand tonnes of saleable coal 5.3% of total Africa) was produced in 1985. This production was roughly equally shared by Niger and Nigeria. In the ECCAS subregion, Zaire produced all the 121 thousand tonnes (2.2% of total Africa) of saleable coal ouptput during 1985.

40. Political, economic and technical factors allowing and taking into account existing coal developemnt programmes, it is estimated that saleable coal production in the countries of Africa will rise to nearly 14.0 million tonnes of saleable coal by 1995. During the year, it is expected that 10.0 million tonnes or 73.1% of the coal will be produced in the SADCC/PTA subregion; 2.3 million tonnes or 16.8% from the North African subregion; 1.2 million tonnes or 8.7% from the ECOWAS subregion; and 0.2 million tonnes or 1.5% from the ECCAS subregion.

III. AVAILABILITY OF INDIGENOUS SOURCES OF ENERGY IN BURUNDI AND MADAGASCAR

11.1 Burundi

(a) Peat

41. Burundi's peat resources are a potential substitute for fuel wood, for small industries and for rural institutions, and perhaps eventually for urban households. Over the past few years the assessment and development of peat resources in Burundi has become much more systematized. The development of peat in Burundi is supervised by ONATOUR, the parastatal company under the Ministry of Mines and Energy.

42. The principal issue in the peat sector is the uncertainty about the extent of exploitable peat reserves. According to ONATOUR the annual production of peat in Burundi is about 15,000 tons. As the energy source peat is used in improved stoves in the public schools and military barracks, but it is not yet used at the level of individual family.

43. ECA in 1987 has sponsored the study on peat resources in CEPGL subregion and commissioned for this study EKONO Group of Finland. The Report on utilization of peat in Burundi, Rwanda and Zaire was submitted to CEPGL member states in 1988.(2)

44. Burundi is the leading country in the CEPGL subregion in peat development. Its resources have been surveyed to great extent and the country has steady peat consumption in several consumer sectors.

45. Exploitable peat resources in Burundi are estimated at 57.4 million tons on wet basis with 30% moisture content. The reserves are located in three main areas, these are the Highland bogs, Nyamuswaga and Akanyary river valley. Peat reserves in all these areas have been evaluated by ONATOUR and the corresponding figures could be found in the report by EKONO.(2)

46. The main consumer of peat in Burundi is the institutional sector with the Army as the major consumer. In 1987 the Army consumed about 9,500 tons of peat out of the total consumption of 11,500 in the same year.

47. The total production during this year was considerably higher and as a result the stockpiles have been growing. There is no need to increase stockpiles, because the production conditions are fairy stable therefore, it is necessary to match the production with the real consumption.

48. The institutional sector is a steady market for peat and especially the Army which covers approximately 80% of the total. Therefore the planning for new production should take into account the actual stock level and the demand based on firm contracts.

49. The selling price of peat in 1987 was a 8.0 FBU/kg in Bujumbura and 5.5 FBU/kg at production site. The economic cost of fuelwood according to the World Bank estimate was FBU 3.3/kg therefore, the price of peat was not competitive enough (3). The EKONO report recommended that new production of peat should be on the limited scale until the stockpiles are consumed. ONATOUR should try to minimize the production cost of peat and at the same time to increase the production efficiency.

50. There are a number of potential consumers of peat in industry which may consider peat option as substitution to imported oil, fuelwood and electricity. The list of the potential industrial consumers includes Cotebu textile factory, two breweries in Bujumbura, two dairies and four tea factories also located in the capital. There are numerous bakeries and restaurants in Bujumbura which may be switched to peat as a source of energy.

51. Among the on-going projects in peat utilization perhaps the most important is the study on peat briquetting. The study has revealed that peat briquetts are cheaper per kilogramme than charcoal (15 FBU against 20 FBU) and briquetts can be recommended for utilization in rural areas.

II.2. Madagascar

(a) Domestic Oil and Natural Gas

52. Madagascar has been exploring for oil and gas for a number of years. Depending on an outcome of a hydrocarbon exploration effort now under way Madagascar oil and natural gas may be one of the most important of the available energy options.

53. In 1981 the Office Militaire National pour les Industries Strategiques (OMNIS) invited oil company participation in the search for hydrocarbons and an accord was signed with Mobil. According to the agreement Mobil was expected to carry out an eight year exploration programme on its concession. The accord also included provision for the state to take a 51% particiaption in any commercial find.

54. In 1982 three further concessions were awarded by OMNIS with conditions similar to those pertaining to the Mobil concession. Agip was awarded an exploration licence on a block of 20,000 sq. km which is located on the north side of the island and includes both land and off-shore areas. Amoco was assigned the block of 25,000 sq. km. on the west side of the island and Occidental held a third block of almost 20,000 sq. km. The same year seismic and aero-magnetic programmes have been carried out by the concession holders which led to a drilling campaign. The statistical data of the exploration programme in Madagascar is summarized in the Table 1.

55. As a result of this exploratory effort the commercial reserves of heavy oil have been confirmed in Tsimiroro field, known for many years. Madagascar has consideable potential as heavy oil producer. ONIMS has began to investigate the potential of the heavy oil in Tsimiroro and they have already launched a major study on heavy oil recovery. The original plan enviseged the drilling of about 10 test holes in the 1,500 ft. depth range to assertain the quality of the deposit. This work was financed by an USD 11.5 million from IDA. An additional 5.0 million was provided by OPEC fund and it was estimated that about USD 18 million will be required to establish the potential of the area.

56. In 1987 the Petro-Canada International Assistance Corporation (PCIAC) finished processing and interpreting some 4,000 km of off-shore data collected the previous year in the northwest Amilobe Basin and south of the continental shelf of Madagascar. On the same year OMNIS and PCIAC signed a second co-operation agreement and launched an onshore exploratory drilling programme west of Menambolo in the Morondava sedimentery basin. After seismic verification to locate the best drilling position the well West Menambolo 1 was spudded. Drillstem tests were done on two Cretaceous sands intervals

which yielded gas flows of 6.3 MMCF/D and 9.5 MMCF/d respectively. The well was suspended as a potential gas producer. The presence of potentially commercial hydrocarbon reserves in the Cretaceous opened up new exploration opportunity in western Madagascar.

57. Back in 1985 the US Department of Treasury published an estimate of the potential recoverable resources of oil in Madagascar. This estimate was preapred for two scenarios, high and low and the figures are presented in the Table 2.

Table 2

Potential recoverable resources of oil in Madagascar

(millions of barrels)

Recoverable resources	High	Low
Estimated land and shallow water resources	1,125	355
Estimated deep water resources	720	435
Estimated total resources	1,845	790

58. Assuming the level of reserves indicated in Table 2 are proven, the cost of these developments may be obtained by using unit costs, i.e. USD 3/barrel of reserves for land and shallow water and USD 6/barrel of reserves for offshore (in 1980 USD). Therefore, the finance required for the high scenario will be approximately USD 8.0 million and 4.0 million for the low scenario.

59. As stated above petroleum exploration in Madagascar is carried out by multinationals under concessions agreement but level of royalty and income tax rate are highest among African member States, constituting 20% and 45% respectively. It seems extraordinary that Madagascar, non-producer is on the top with regard to royalties, however, this situation is a function of the Government thinking rather than the reflection of the resource potential.

60. The conditions for petroleum operations in Madagascar are the following: duration of the contract eight years for exploration and fifteen years for exploitation, the Government is imposing the corporation tax, plus a direct tax based on the profitability which rises from 25% on a profitability of 15% to 75% on profitability rates of 25% and over. In case of natural gas royality is down to 15%.

61. Refining capacity of Madagascar was limited by 18,000 bbls/day but an extension permitted the refinery to produce about 70,000 tonnes/year of gasoil, 5,300 tonnes/year of petrol and 20,000 tonnes/year of bitumen. The crude is essentially imported from the Persian Gulf and the refinary traditionally operates at 60 to 70% of its full capacity.

(b) Tar Sands

62. In the region of Bemolanga located at about 500 km north-west of Antananarivo there is deposit of tar sands. This deposit has an area of about 400 sq. km and geological reserves of it in 1970 were estimated at 3,000 million tons. As it was indicated in the earlier reports of UNDP, the development of Bemolanga deposit seemed possible. Bitumen is likely to be converted into petrol, used for electricity generation and residual tar (asphalt) may be utilized for surfacing of the roads. However commercial feasbility of such an undertaking was not studied that time.

63. In 1981 the study on a promising bitumen extraction process was undertaken financed by IDA. OMNIS hired an Italian firm to test their process on the tar sands from Madagascar and also study the necessary on-site upgrading of the bitumen. The studies showed that extraction of the bitumen was not economically feasible at that time price of oil and with the currently available technology. There still an interest in OMNIS to develop this deposit and the organisation continues to identify and consider new processes which might eventually make oil extraction from the sands economical. Given the present circumstances in the world oil market and existing trends in the prices escalation, the Bemolanga project may become economically feasible.

(c)Coal

64. The Madagascar's coal resources have not been exploited commercially because of low oil prices and because of their relative remoteness from markets and the lack of industrial demand. In view of the changing economic situation the interest to coal was recently revived.

65. The overall coal potential of Madagascar is estimated at 150 million tons in the ground and about 100 million tons are concentrated in the Sakoa field. This field contains medium volatile steam coal with the moderate ash content. The Sakoa coal field was studied in detail by many experts from major coal producing countries (UK, Canada, FRG) and from international organizations (UNDTCD, ECA). Some of the experts estimated the potential of this field at 1.5 million tons for export and recommended to use dicards for electric energy generation.

66. The Government of Madagascar back in 1987 has invited ECA coal on expert who visited the Sakoa and Sakamena coal deposits and presented a comprehensive report on development of coal in Madagascar (4).

67. The major conclusions of this study were that OMNIS' approach to developing of Sakoa is justified and it is necessary first to install small production unit for domestic needs and proceed with the installation of a larger unit if and when the international coal market recuperates.

68. The coal resource potential in Sakoa is sufficient for such an approach. The potential for export will be about 1.5 million tons as indicated by the general character of the field.

69. The establishment of the infrastructure cannot financially be borne by the coal exports. The road and rail have to be established for this part of Madagascar anyway and coal can contribute to repayment in the long term but would not be the only beneficiary. Other industries could be the spin-off, such as cement manufacturing, various agricultural enterprises, small industries etc. If the Government of Madagascar waits with infrastructure for coal to finance it alone, this would last for very long time.

70. There is possibility of intra-African co-operation in the development of Sakoa field. For example the facilities already existing in Swaziland (Emaswati) can be used for laboratory study and perhaps a joint venture in coal development can be proposed.

71. Power generation at the mine mouth should be one objective of the overall Sakoa project. This is not only to be established for the consumption of the mine, but also for distribution of electricty to rural areas. The discards of the coal benefication plant could be the feed stock for the power plant which should be initially of small size and gradually be increased by adding further units later on.

72. Summarizing the suggested by ECA overall objectives of the Sakoa coal project, it should be planned as a small to medium size, gradually to be developed for indigenous consumption (cement, small inudstries, households, energy generation) and for the export to neighbouring African countries and islands.

IV. POSSIBILITY OF SMALL SCALE DEVELOPEMNT OF OIL, NATURAL GAS, COAL AND PEAT IN BURUNDI AND MADAGASCAR

(a) Oil and Natural Gas

73. In Madagascar hydrocarbons may offer a major opportunity, although the prospects for their development and timing of the development are still uncertain. However it is the right time to be prepared to take this opportunity, should it arise. Almost certainly, wise use of the future revenues from oil development can enable Madagascar to develop a strong and sustainable energy system based on this resource.(5)

74. The position of the Madagascar's Government with regard to natural gas is different from that of oil. The discovery of gas prone areas despite being geological success was not followed by commercialization given the absence of markets and high costs of the infrastructure which restrained the development and use of this versatile fuel.

75. Even in the light of recent technological developments, tar sands of Madagascar remote from the large centres of consumption seems for the moment to involve such difficulties and high capital investment that their exploitation will presumably not be considered in the near future.(6)

76. In view of the above the only commercially viable source of energy capable to substitute oil in Madagascar is coal.

(b)Coal

1.Madagascar

77. Madagascar intends to develop its coal resources in a three step approach:

(1) to start a small openpit test mine of approximately 5,000 tonnes/year coal production in order to supply coal to local consumers and to enhance indigenous coal consumption by making coal available to the population; (2) to install a small to medium sized openpit production unit as soon as quality products for the local market can be produced be a suitable coal benefication plant and as soon as some basic infrastructure investments for roads and bridges have been done; (3) to strive for a larger unit of 1 to 1.5 million tons clean coal production per year in the long term if and when the international coal markets recuperates and if and when the investment of a railway line to the coast and a shiploading plant can be afforded.

78. The ECA conclusion is that this phased approach represents a logical and consequential decision, commensurate with the presently known resource potential of 150 million tons of coal in the ground of which approximately 100 million tons in the ground can be regarded as indicated and inferred mineable in situ reserves (Sakoa area). Of this, 23 million tonnes can presently be regarded as opencast and strip mineable, probably resulting in 14 million tonnes of saleable clean coal.

79. The studies of BP in 1985 reached the conclusion that the necessary infrastructure for coal exports into the international markets can only be established with a decent return on the investment if five or ten million tonnes of saleable coal products could yearly be produced. The overall potential of Sakoa does not justify such a major coal export project. The step-wise approach to the coal development provides initially for a minor production unit for test purposes, which probably will be developed into a medium sized coal mine of 100 to 200,000 tonnes/year if markets for this coal could be found or generated. Later on if and when the international

markets should recuperate, several production units of combined 1 to maximum 1.5 million tons could be contemplated. According to the findings of BP Coal and ECA expert, the necessary infrastructure measures regarding new roads, rail and shiploading facilities cannot financially be borne by a minor or medium sized coal project.

80. However in view of the fact that smaller quantities and smaller shipsizes do not require the same or a very similar investment amount for a shiploading plant as for a mega project, the possibility of a more moderate investment approach should be assessed. If smaller quantities will have to be shipped over shorter distances to adjacent island states and not to faraway African coastal countries, smaller shipsizes should suffice. It is moreover conceivable that all the rail connection need not to be of a high performance unit train structure, but could consist of a more modest, even narrow gauge rail installation, just sufficient to move produced coal to tide-water. It should also be checked whether the existing bridge and embankment structures, left uncompleted since colonial times, could be used in order to minimize investment costs.

81. Consideration should also be given to the fact that not only the anticipated coal mining industry would benefit from the expensive infrastructure measures, but also other industries and possible agricultural projects. There is a major cement manufacturing complex for export which may utilize coal for power generation. Agricultural cash crop projects for exports should be considered as co-users for the new railway line and/or road connections and should likewise contribute to the amortization of the infrastructure investments.

82. As shown above by evaluation of the respective costs, the establishment of a rail connection to the coast appears to be of utmost importance, even if only a medium sized production unit is established. It is shown that, if average specific index figures are used, which are applicable in world wide comparision, road transportation over long distance (220 km) is excessively expensive and cannot compete with rail transportation of bulk material of this kind. It will, however, not be feasible to finance the necessary infrastructure measures by the coal project alone. Roads, rail and shiploading plant should serve diversified purposes and be paid back by multiple exports and by increased domestic development.

83. The character of the Sakoa coal project as part of a general development project for the under-developed south-west area of Madagascar appears to render this project eligible for technical and financial aid by interested donor countries. Whether such a major development can be initiated, will largely depend on the private sector. In this connection also the coal demand for power generation should be mentioned here. In view of the destitute transportation infrastructure, a power plant based on coal should be considered at the mine mouth first. This power station should make use of the discards from the preparation plant, which should still contain a notable heating value that can be used at low costs. As this is practised elsewhere in Southern Africa, it could considerably contribute to low fuel cost power generation and to the optimization of the overall project.

84. In view of the involvement of many divergent disciplines exerting financial, performance, and cost influence on the whole project, it appears to be exigent to conceive and to co-ordinate integrated studies on the entire chain of coal production, benefication, transportation and shiploading. These studies should be flanked and supported by a coal market survey covering the adjacent Indian Ocean island states and not too far distant coastal African countires that could become customers. Also the establishment of a coal based power station and the potential for development of Madagascar's secondary industries such as cement manufacturing and agricultural cash crop developemnt for further exports, should be taken into consideration.

85. First of all the operation of a small open cast test mine (5000 tonnes/year) should be exploited for the generation of laboratory scale and industrial scale preparation test. The work is to be conducted by a coal quality research institution which has accumulated profound experience and state-of-the art expertise in the field of Southern African coal quality and coal benefication technology. These studies should result in an operating and investment cost estimate for a suitable preparation plant including conceptual design at an accuracy sufficient for feasibility assessement purposes. They should precede the infrastructural studies and initiated as soon as possible.

86. Since it is a task of this benefication test work and of these studies to determine how to improve and to adjust the quality parameters of coal according to market requirements and how to satisfy specific coal demand crieteria, a parallel survey on the potential markets should be conducted. This survey should cover the already coal burning industries that are situated in not too distant African island or coastal countries and should also deal with potential developments.

87. It is of importance that the potential quality features of Sakoa coal and the requirements of the markets and of the potentialities of developing industries in these island or coastal countries are dealt with in co-ordination. For example if one island considers the design and construction of a thermal power plant on coal basis, it is important to contact the respective power authority in time in order to let them know the possible range of coal specifications and to possibly influence the plant design. If the design of a themal power plant is done on the basis of high volatile coals, it is difficult to substitute it by low volatile or antracitic coals and vice versa. Sakoa coal may have a good chance to be considered already during the power plant design because of its medium to high volatile content which is sometimes preffered for power generation, as well as because of its low sulphur and possibly low ash content. Coal's poentially high calorific value is also an advantage. Advertising and customer acquisition related efforts on the basis of profound knowledge and expert representation of the inherent and realizable quality features and conveying confidence in the reliability and competitiveness of the future coal deliveries, appear to be essential prerequisits for a successful and aggresive market penetration. It is evident that the studies on coal quality and market related issues mutually complement each other and require intensive care and co-ordination.

88. Reference is here repeated to the expertise which is in fact available in some Southern African countries, as for example in Zimbabwe and in Swaziland with respect to coal quality and benefication issues. There is a suggestion to contact producer in Swaziland that in itself successfully operating a small to medium sized coal mine under comparable conditions. It does not seem possible that such a producer could render consultant advice with respect to coal benefication issues and could arrange a coal preparation test and research programme as well as a conceptual design study and the appropriate cost estimates. This would be the more successful and least risky since coal mined by the company in Swaziland is completely different in quality, in fact anthracite, which would from the very beginning exclude any competitive rivalry as far as markets are concerned.

89. An industrialised donor country could also be addressed for technical assistance for the planning, initiation and carring out of a thoroughly designed coal preparation test work, evaluation and conceptual planning programme. However the time requirement for the application process may be lengthy and the outcome insecure. If the first suggested approach of consulting an African coal mining establishment was not regarded preferable or feasible, then the request for technical and financial assistance from a European or North American industrial donor country could be an alternative.

90. A further study intially at a pre-feasibility accuracy should be initiated on a suitable power plant concept. In view of the status of the infrastructure, a mine mouth power plant should be preferable, at least initially, the conceptual and later on detailed design should take into consideration the quality features of the discards from the expected coal benefication plant in addition to some raw coal as feedstock. The study should determine the size of the power plant units which would facilitate a stepwise increase of power generation commensurate with demand development. It should also estimate the cost of the electric power to be generated and the required investment costs for the implementation. Also the distribution grid of electrical energy supplies should be addressed in conjunction with the question whether the generation of electric power near the consumers would become cheapter if and when the railway line to a shiploader has been established.

91. The other integrated studies which are recommended in the following explanations should also timely follow the coal quality and market related studies as suggested above. Its nature clearly qualifies for international aid and assistance.

92. Assessement of the status and the representativity of available exploration results and of additionally required exploration work should be done for the initiated small to medium size openpit mining operation as well as for the future expansion into additional underground mining at Sakoa and possibly additional openpit mining at Imaloto.

93. Integrated mining engineering and conceptual mine planning studies should be performed taking into preferred consideration strip mining but also low investment cost solutions as surface near room and pillar mining with the employment of scrapers first and later on hydraulic mining. Estimates of investment and operating costs applying a pre-feasibility accuracy during conceptual planning and as the case may be a feasibility accuracy during detailed planning.

94. Integrated studies on road, rail and shiploading infrastructure under the leading principle of low investment cost solutions for medium to large scale quantities of coal up to 1.5 million tonnes coal shipment per year. Parallel to this, consideration should be carried out for additional potential users for the new infrastructure other than the coal producer as a cement plant and new agricultural cash crop projects for exports near the new roads and as case may be near the anticipated railway to tide water.

95. The studies on infrastructure should take into due consideration the results of the coal trade survey and its recommendations for an adequate shipsize range for coal deliveries to adjacent African islands and to not too distant African coastal countries. From this the size, investment and operating costs of the shiploading plant should be defined. Also the investment of only a narrow gauge rail connection between the Sakoa mine and the harbour site using the existing embankments and bridge structures should be compared to the possible rail connection. The infrastructure studies should initially adhere to pre-feasibility accuracy in order to enable the Government of Madagascar to decide in principle on an appropriate mode of transportation and shiploading. Thereafter a full fledged feasibility evaluation with detailed operating and investment cost estimates on the basis of conceptual design should be carried out. This should later on be followed by detailed design in the framework of a project masterplan.

96. These results of the studies should be used for the general project master plan in which the staged project sequence should be defined at a bankable feasibility study accuracy and financing should be sought in co-operation with possible private investors (agricultural cash crop projects, cement manufacturing etc.), with international leading institutions and with interested donor countries.

(c) Peat

97. Burundi is the fore-runner in peat development in CEPGL subregion and there already is a lot of expertise, know-how and experience in various peat development sector. ONATOUR has capable local experts to implement many of the tasks. The following priority areas should especially be developed: (a) a balance between peat consumption and production should be achieved in order to optimize the cost structure and (b) every effort should be made to get industrial customers and especially Cotebu and Brarudi. The Burundi Government should formulate the long term energy policy in their own industries in order to stimulate the progress in peat utilization. Negotiations with Cotebu should be started in order to achieve definite terms for peat project. ONATOUR might consider selling overstock at a lower price to support the investment.

98. After a tentative agreement has been reached the next step is to verify the capital and operating costs by requesting budget type proposals. This should be done by an experienced peat engineering company. The project should then be continued by financing negotiations and project implementation. One of the tea factories should be converted to peat firing as soon as possible. An engineering study should be made in order to design proper equipment and then implement the project. ONATOUR should consider the use of peat overstock to a reduced price as a market stimulator in order to get the project implemented. Again it is vital to use engineers with former practical experience of peat combustion in similar applications. After the successful demonstration the others can follow the suit.

99. It is necessary to use peat in brick manufacturing and to continue research on increased productivity. Private contracts for certain users should also be considered.

V. CONCLUSIONS AND RECOMMENDATIONS

100. Striving to overcome the sharp rises in the price of oil during the 1970s the African member States were pursuing the drive towards the development of indigenous conventional sources of energy as well as the improving of energy efficiency and conservation. This drive was undertaken through the implementation of a number of programmes aimed at the development and use of domestic indigenous conventional resources. Enhanced energy efficiency and energy conservation were also accorded priority but to a lesser degree.

101. There is no doubt that Burundi and Madagascar are going to be hit by the currnet increase in the price of oil. However none of the petroleum experts can predict how long-lasting this hike could be or how high it could be. The rise from the bench mark of 18 USD a barrel to 36 USD now underestimates the true rise that has taken place and will take place, but no expert has any way of deciding whether it will go up to 40 USD a barrel and stay there for some considerable period of time. One thing is for sure - it is bad for the economy of Africa to have a price of oil going up. On top of that the African countries with lots of their piled-up external debts are likely to be hurt heaviest.

102. The boom experienced by African oil producing countries after the shocks of 1973 and 1979 was not always effectively converted into lasting economic development. Exploration activities in these countries did not increase substantially after the two oil shocks, as might have been expected, on the other hand, it has not declined as early or sharply in the 1980s as in some other group of countries.

103. The surplus of oil in 1980s has had an inevitable impact on exploration activity in Africa. The prospects for 1990s are set uncertain with the knowledge that the source for oil for many African countries is in the Middle East, where the world's proven reserves are highly concentrated.

104. It should be recalled that the first tremendous and devastating oil crisis happened in the wake of the Middle East war of October 1973. The sudden increase in the price of oil in 1979 after Iran's revolution has resulted in dislocation of many economies in Africa.

105. Now the international community and Africa in particular are facing the third oil shock and consequent economic recession because of the current Gulf crisis. The crippling effect of this oil crisis now expressed in skyrocketing oil prices (above 30 USD a barrel against 18 USD only six months back) in international oil market will have a long-term effect.

106. Africa will remain highly import-dependent on oil in the foreseeable future.(8) This confirms an assumption that unfavourable international environment influences the development of commercial energy sources to such an extent that forecasting the future developments in the energy sector is an extremely difficult task.

107. Besides oil several of the African countries have natural gas reserves as large as or even larger than their oil fields. Although few of these enjoy bright export prospects (Algeria, Libya and Nigeria) in several African countries natural gas could have been exploited locally for power generation, industrial fuel and feedstock for petrochemical projects (Cote D'Ivoire, Mozambique and Tanzania).

108. Given the importance conventional sources of energy may have in the commercial energy consumption pattern of the countries considered in this report, it is imperative that more emphasis be given to ways and means of accelerating exploration and development of indigenous energy resources such as oil and gas, coal and peat. In this respect it may be noted that Burundi being land-locked country is facing difficult problems in importing petroleum products. The supplies have to be transported in relatively small quantities over long distances on inadequate facilities which add considerably to overall costs. In fact Burundi has one of the highest CIF cost in Africa for petroleum products.

109. Madagascar has considerable reserves of unconventional crude oil and potential of the country as heavy oil producer is great. There are deposits of tar sands in Madagascar, but in the short and medium term, there is virtually no chance for heavy oil and tar sands making any contribution to petroleum production in Madagascar. The current oil supply situation and necessity to develop technologies capable of economically extracting oil from various sands makes the development of these resources unlikely.

110. As with oil, finding and developing natural gas resources in Madagascar will be costly and technologically demanding. The availability of natural gas in Madagascar will not be the limiting factor for exploration effort during next ten years. Rather, it is the development of major gas transport systems, the ability of producers and consumers to complete contracts and the development of local markets which will determine the rate at which

reserves are located. With Mozambique and Tanzania developing their proven natural gas resources and with coming up Madagascar there is no doubt that southern part of East Africa has the potential to become a major gas province, provided the conditions outlined above can be met.

111. Petroleum exploration and development in Madagascar may bring in their wake a number of social issues. These are generated by production activities (influx of outsiders, "boom town" effects, environmental threats, the impact on tribal people etc.) and by consumption effects (the social impact of new kinds of commercial energy, changes in the level and distribution of income, rising expectations). These issues are sometimes neglected, but if instead are given timely attention, they can usually be managed in such a way that the positive effects will predominate. In this respect the long lead times, characteristic of petroleum projects can if utilized properly, be turned to good advantage.

112. In addition, it is prudent as a part of the Madagascar's energy planning to prepare for the contigency that oil would not be discovered in commercial developable quantities, or that it will not be developed for a decade or even two decades. The risks are too great to assume that hydrocarbons will be the answer, even though the prospects seem fairly good, that it will be at least part of the answer.

113. Development of coal in Madagascar as part of a general development prospect for the under-developed south-west areas of Madagascar appears to render Sakoa project eligible for technical and financial aid by interested donor countries and financial aid by interested donor countries and financial institutions. Whether such a major developemnt can be initiated, will largely depend on the possibility to attract a major capital influx also from the private sector.

114. Peat in Burundi will not be probably available in quantities sufficient to allow significant substitution for oil unless new bogs are developed. Peat could most easily be substituted for oil where oil is used to generate steam or process heat.

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